Measuring the economic effects of the energy transition with the Three-ME model

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ADEME

Agence de l'Environnement et de la Maîtrise de l'Energie

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The ThreeME Model

Macroeconomic Multisectoriel Model of Evaluation of the energetic and Environmental policies

Conceived by the ADEME and the OFCE since 2008

(Observatoire Français des Conjonctures Economiques)

Aggregate Supply and aggregate demand model,

Like the « neo keynesians » models which are currently used for the economic forecasting (Mesange INSEE and the Direction of the tresory, NEMESIS from Paris 1)

The model combines a top-down approach based on a neo-keynesian structure and bottom-up features in the modelling of consumption behavior

The ThreeME Model

- Macroeconomic Multisectorial Model for the Evaluation of Environmental and Energy policy

  - *Prices are not perfectly flexible (Mark up theory)*
  - *Wages are not perfectly lexible (Wage settings curve)*
  - *Interest rate is fixed by the Central Bank (Taylor rule)*
  - *Supply and demand interact together.*
  - *Increase in energy efficiency and sobriety with the fuel prices*
  - *Investment choices between energivor and sober equipments*
  - *Substitution between energy sources and transportation modes*

A multisectorial model

- 24 production sectors and17 energetic sub-sectors
  - *The model takes into account the effect of a demand transfer from a sector to another in:*
    - Employment and energy consumption,
    - Imports and exports
    - Hence the demand level and economic activity
    - Ex: a growth in renewable energy and a decrease of thermic central production lead to a growth in employment since they are more jobs intensive, and a decrease of energy imports.
- It takes into account the impact of credit supply on the production capacities (the monetary creation).

A double dividend

- Hence the eviction effect between investments is only limited

  Since spendings are not only financed by saving but also by credit supply

  Ex : a growth in building renovation
  - Does not generate a drop in housholds consumption in others areas,
  - People spendings diminishe only by an amount equal to the annuities of debt induced by the renovation, less the amount of energy savings.

- One can show the existence of a double dividend
  - Not only because of a switch beetwen labor taxes and energy taxes

- *Ex : A growth in renewable investments*
  - Generates a growth in global investment (the eviction effect is only limited)
  - That entails a growth in jobs and consumption (the supply boosts the demand)
  - Which leads to a increase in production (the demand boosts the supply)
  - And a decrease in unemployment

The consumer's trade-off

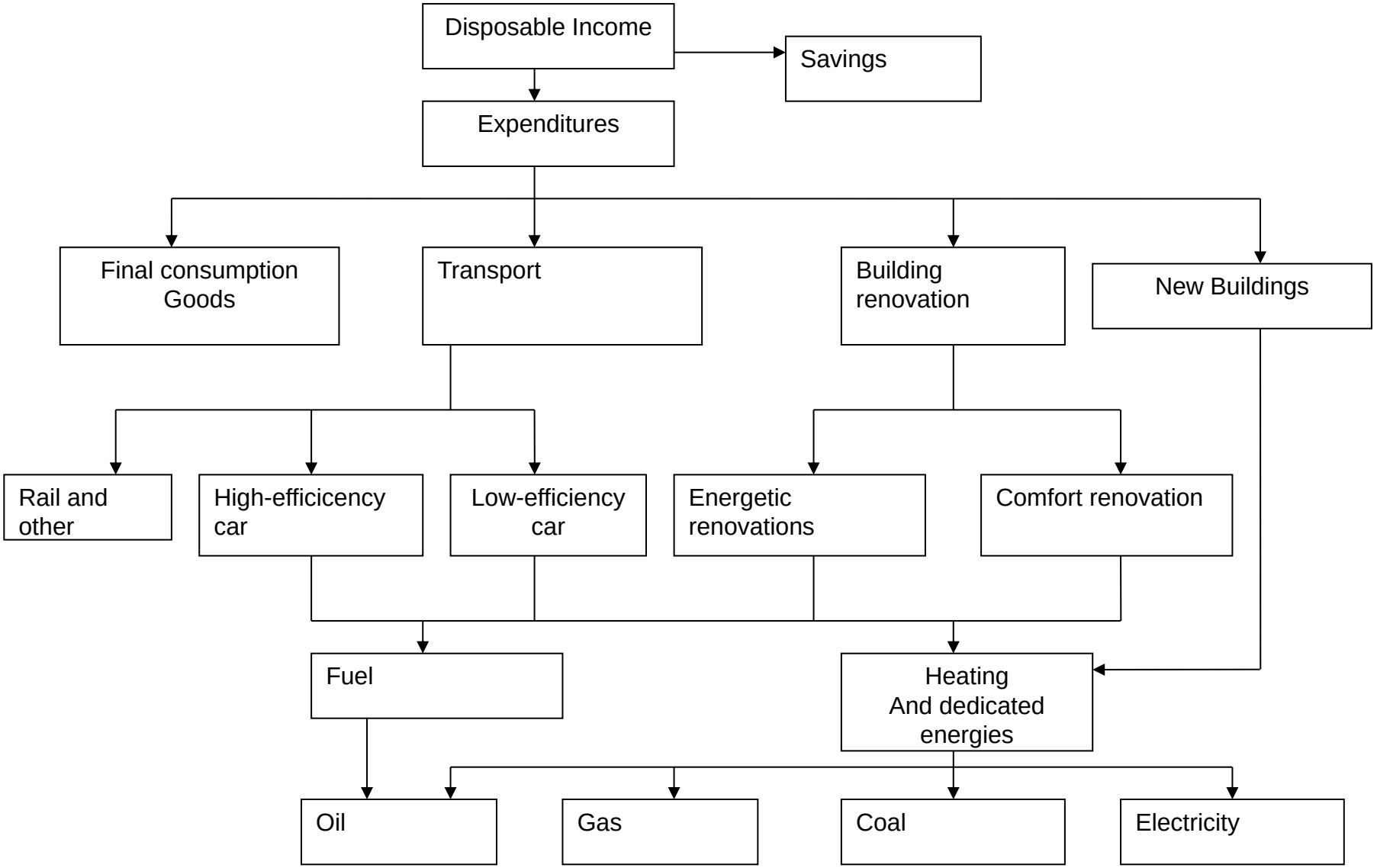
- *The energy consumption is not directly related to income*
  - Energy related to the number of buildings and cars
  - Avoids unrealistic rebound or wealth effects

  Ex : Heating at 35 ºC ! Having 5 cars per person !

- *The households base their investment trade-off between the different energy classes according to the usage cost.*
  - There are three classes of housing and vehicules.
  - The usage cost is function of the energy cost, the cost of investment,the credit cost and the public subsidies.
  - Their market shares evolve according to the evolution in the using costs.

- *A sobriety effect is taken into account through the price dynamic.*
  - The households reduce their heating and fuel expenditures when there is a rise in the energy prices.

The consumer's trade-off



The producers trade-off

- ***Supply*** *(production and imports) is determined by the demand*

  Desired production factors quantities are determined by profit maximization
  - Under a constraint of a KLEM production function
  - Under a constraint of prices relative rigidities: they adjust slowly to the optimum (mark-up over united costs)

- *Firms do some investments in energy efficiency*

  - There is a capital vs energy substitution when its relative price is growing
  - They may change their energy sources
  - There is an endogenous technical progress .

The Business As Usual (BAU) scenario

- *Policies are not modified*
  - subsidies
  - Energy taxes

- *The growth rate is equal to 1.8%*

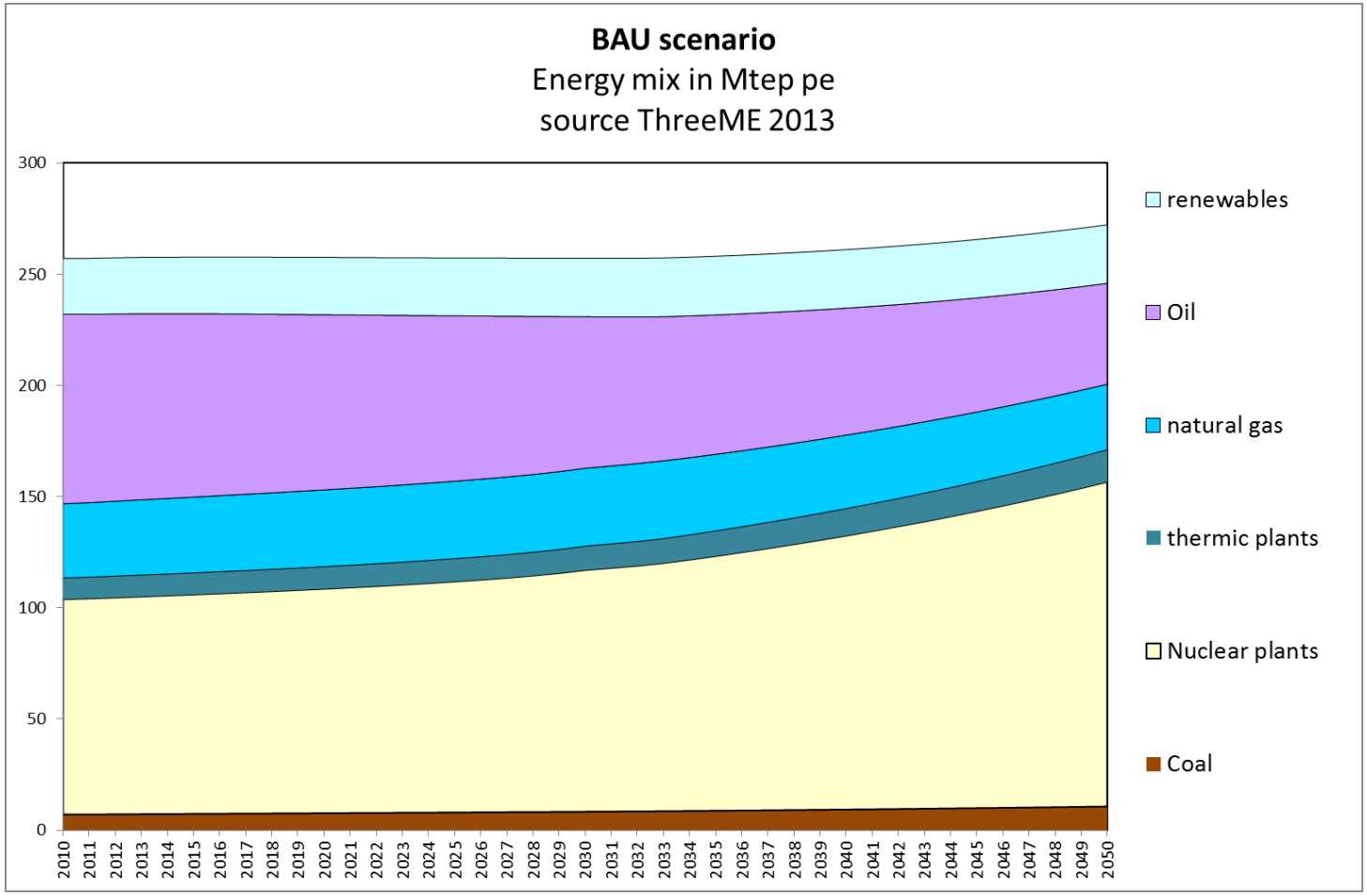
  Sum of the productivity gain (1.4%) and the population growth (0.4%)

- *Energy prices are the same as the IEA forecasting*

- *Virtual scenario, which allows to appreciate the modifications induced by the transition.*

⇨ Final energy consumption is equal to 156 MtepEf in 2030 and 138,5MtepEf in 2050.

The mix Evolution in the BAU scenario

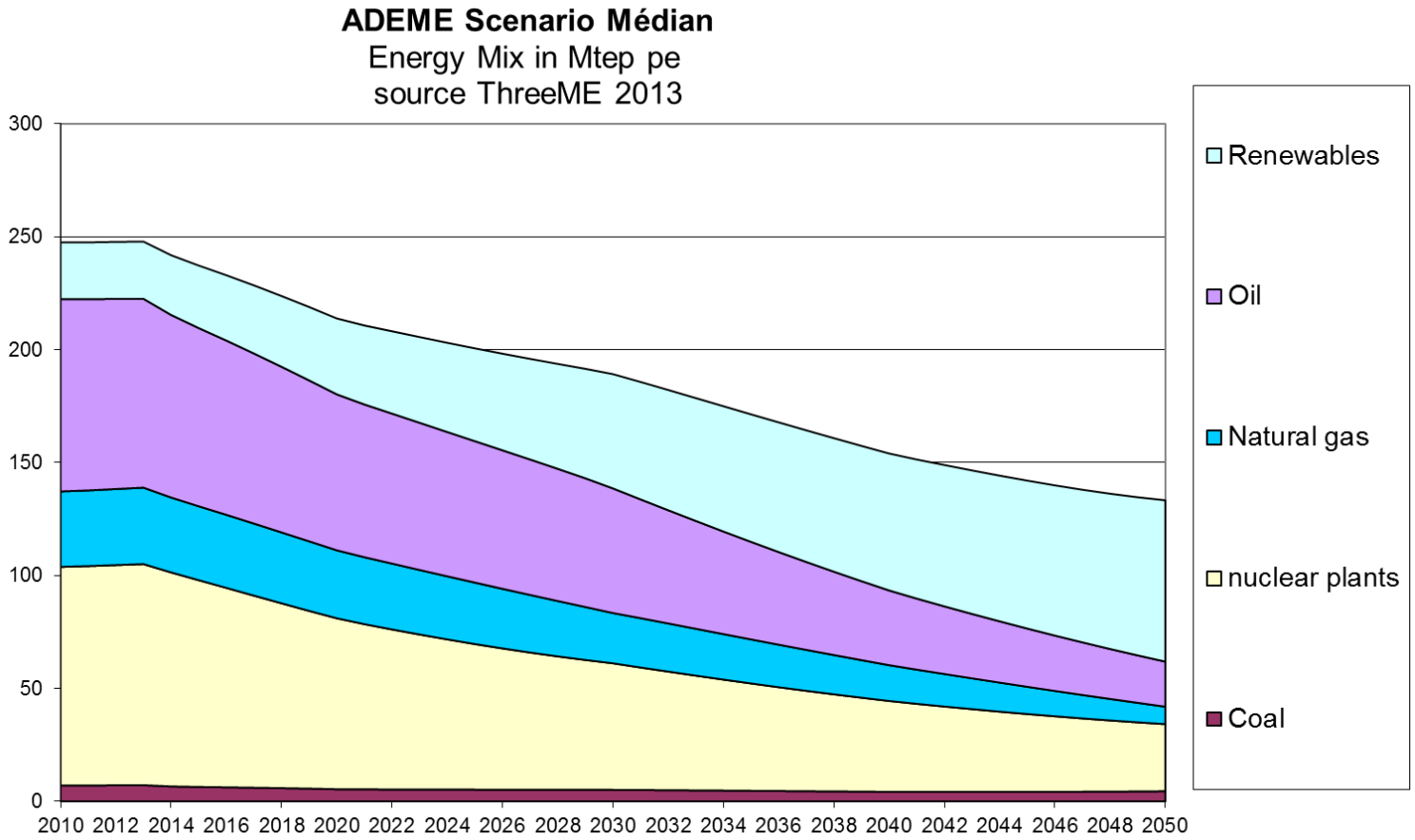


The BAU scenario is modified by exogenous shocks

- *An electric mix modification*
  - The nuclear share reachs 50% in 2030, and 25% in 2050 in the scenario Médian, and18% in the « scenario bas »
  - The Coal an Oil electricity plants are closed in 2030
- *A heating mix modification*
  - The natural gas share declines from 77% to 25% in the heat distribution between 2006 and 2050
- *A taxes reform*
  - A carbon tax is implemented and calibrated to reach the desired level of each energy sources
  - (the firms submited to the european CO2 trading system *ETS* are exempted)
  - The carbon tax receipts are distributed to the housholds and to the firms via a decrease in their labour fees
  - A increase in electricity and heating taxes
- *An electrical vehicles penetration(9,9M eq full elec en 2050)*

Three scenarios have been simulated by the ADEME.

- The final energy demand remains always the same.
- On the supply side, the nuclear share is different :
  - *Low Scenario : the nuclear share reachs 50% in the final electricty demand in 2030 and18% in 2050*
  - *Median Scenario : the nuclear share reachs 25% in the final electricty demand in 2050*
  - *High Scenario : the nuclear share reachs 50% in the final electricty demand in 2050.*



The energy final consumption reach 126 MtepEf in 2030 and 78MtepEf in 2050

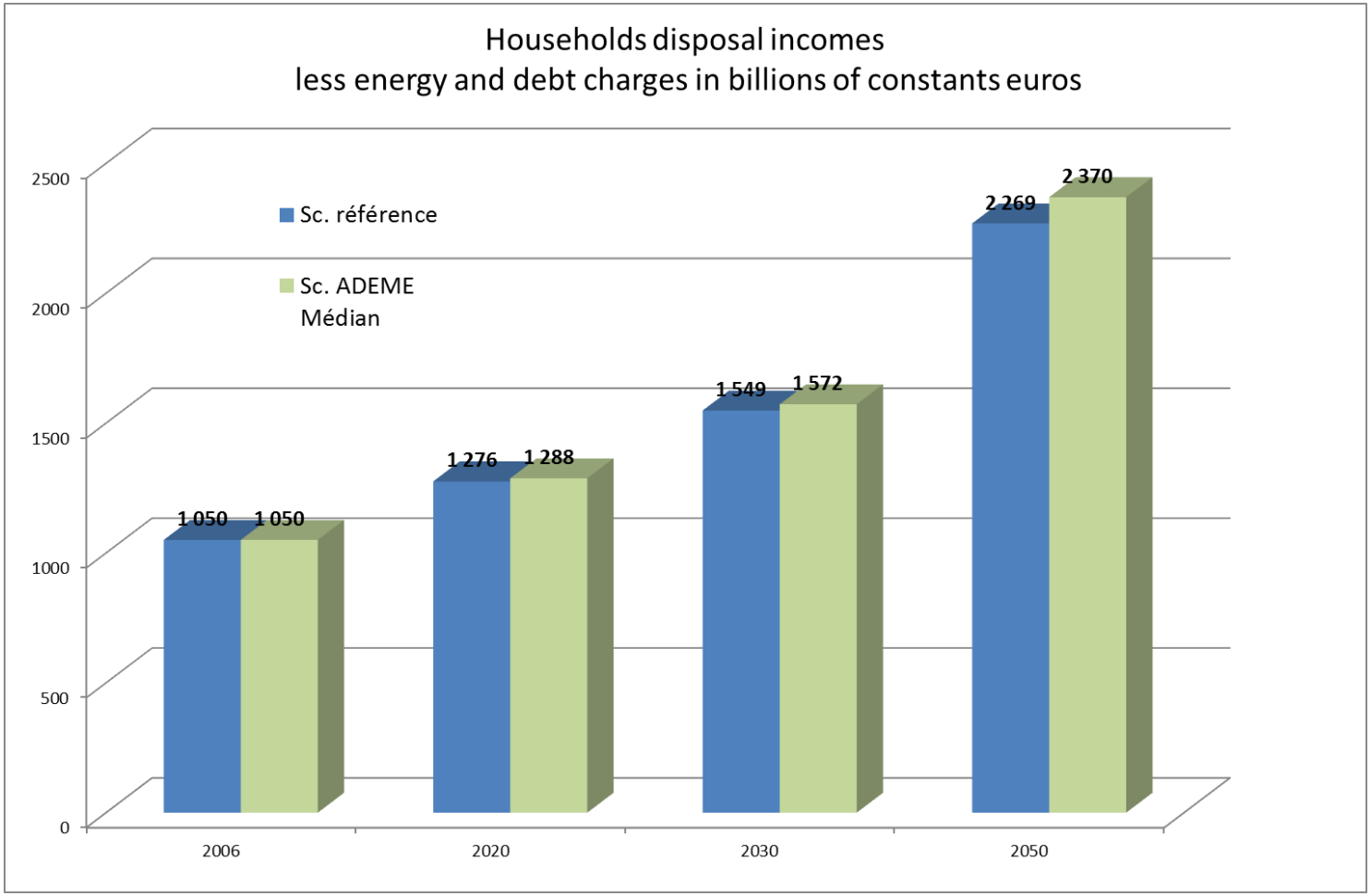
The macroeconomic results

		2013	2014	2015	2020	2030	2040	2050
GDP	(a)	0.00	0.5	0.8	1.4	1.9	2.8	3.1
Consumption	(a)	0.0	0.3	0.6	1.3	1.9	2.7	3.1
Investment	(a)	0.0	3.7	4.9	5.6	5.9	6.6	7.3
Public spendings	(a)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Exports	(a)	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Imports	(a)	-0.1	0.8	1.1	0.8	0.4	-0.7	-0.7
Unemployment rate	(b)	0.0	-0.1	-0.2	-0.5	-0.7	-1.3	-1.5
employment	(a)	0.0	0.2	0.4	0.8	1.2	2.3	2.8
public deficit	(c)	0.0	0.3	0.1	0.0	-0.5	-1.7	-3.9
public debt	(c)	0.0	0.0	-0.1	-0.6	-3.5	-12.4	-33.1
trade deficit	(c)	0.0	0.2	0.4	0.2	-0.1	-0.7	-1.1
GDP	(d)	113	116	119	131	158	190	229
CO2 emissions	(d)	94	90	88	77	61	42	30.5
carbon tax rate	(e)	0	13	16	50	79	198	324
carbon tax receipts	(f)	0	4	5	14	18	30	32

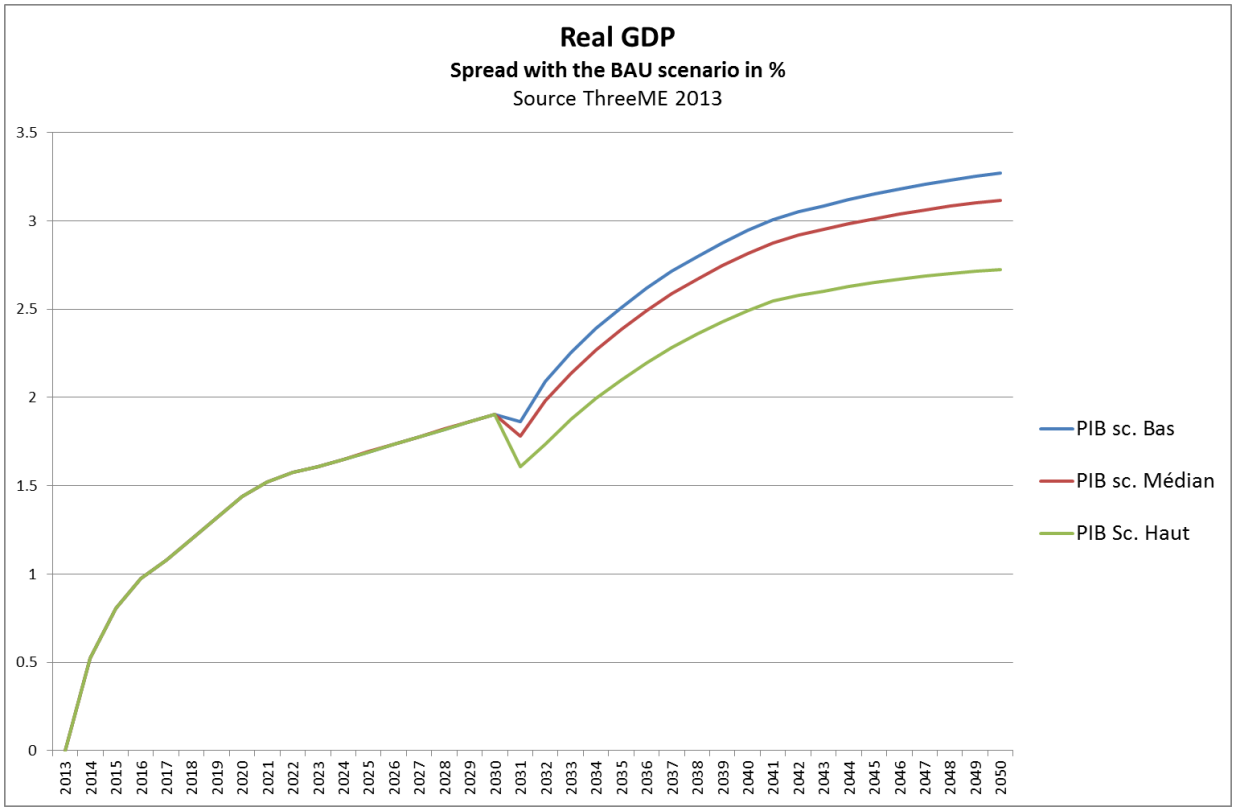
Legend : difference between the"business as usual" scenario unless for (d); relativ difference for (a);
(a) (b) in %; (c) in % of GDP; (d) indice = in 2006; (e) in constant Euros per ton of CO2;

These results were obtained in May 2013. They might change as we will collect more precise datas.

Evolution of the net disposal incomes



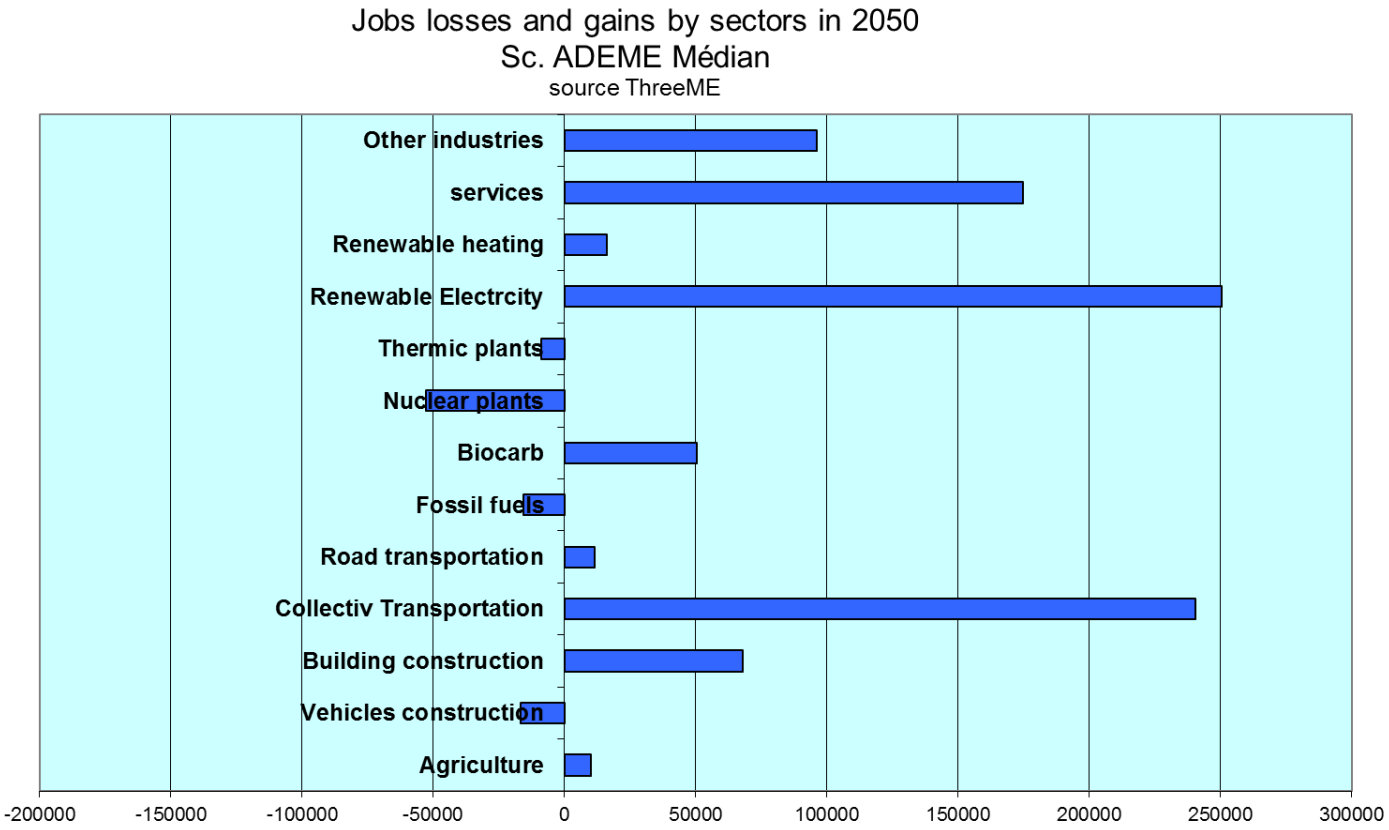
Comparative analysis



The GDP gains are quite the same because:

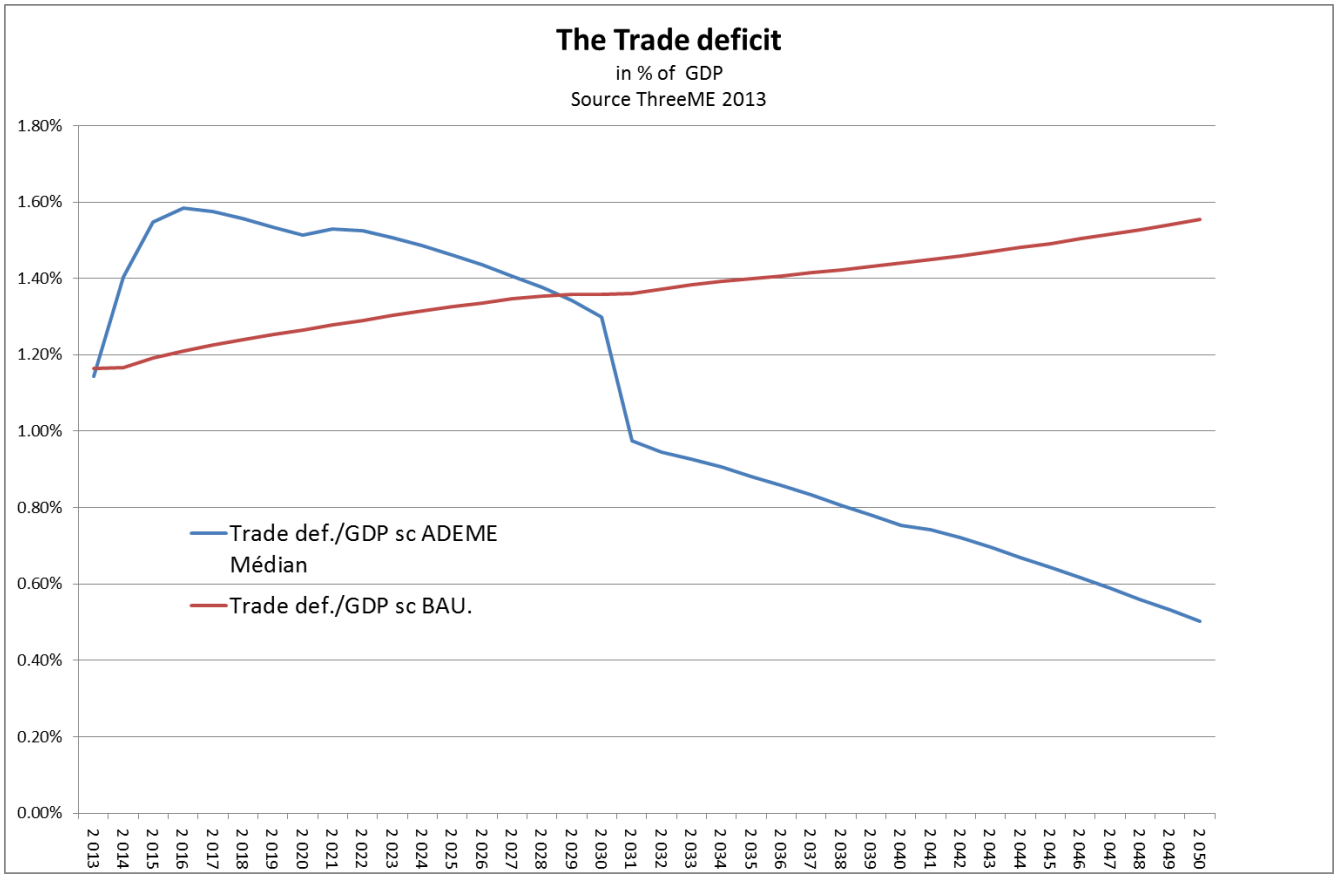
- There is a decreasing in the share of nuclear in the GDP
- The relative convergence between the nuclear and renewables prices

Jobs variations by sectors



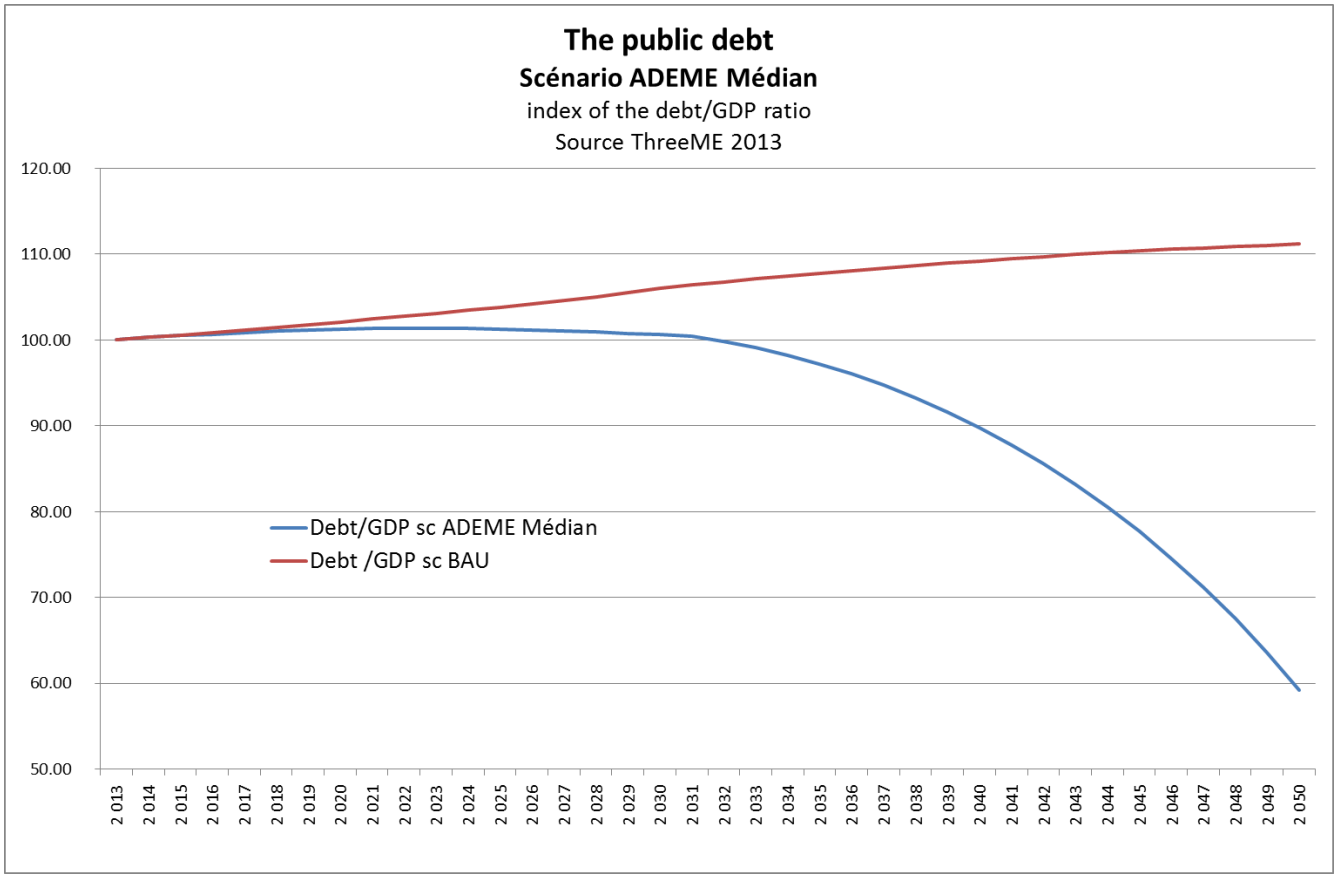
+330 000 jobs in 2030 and +825 000 in 2050

The evolution of the trade balance deficit in % GDP

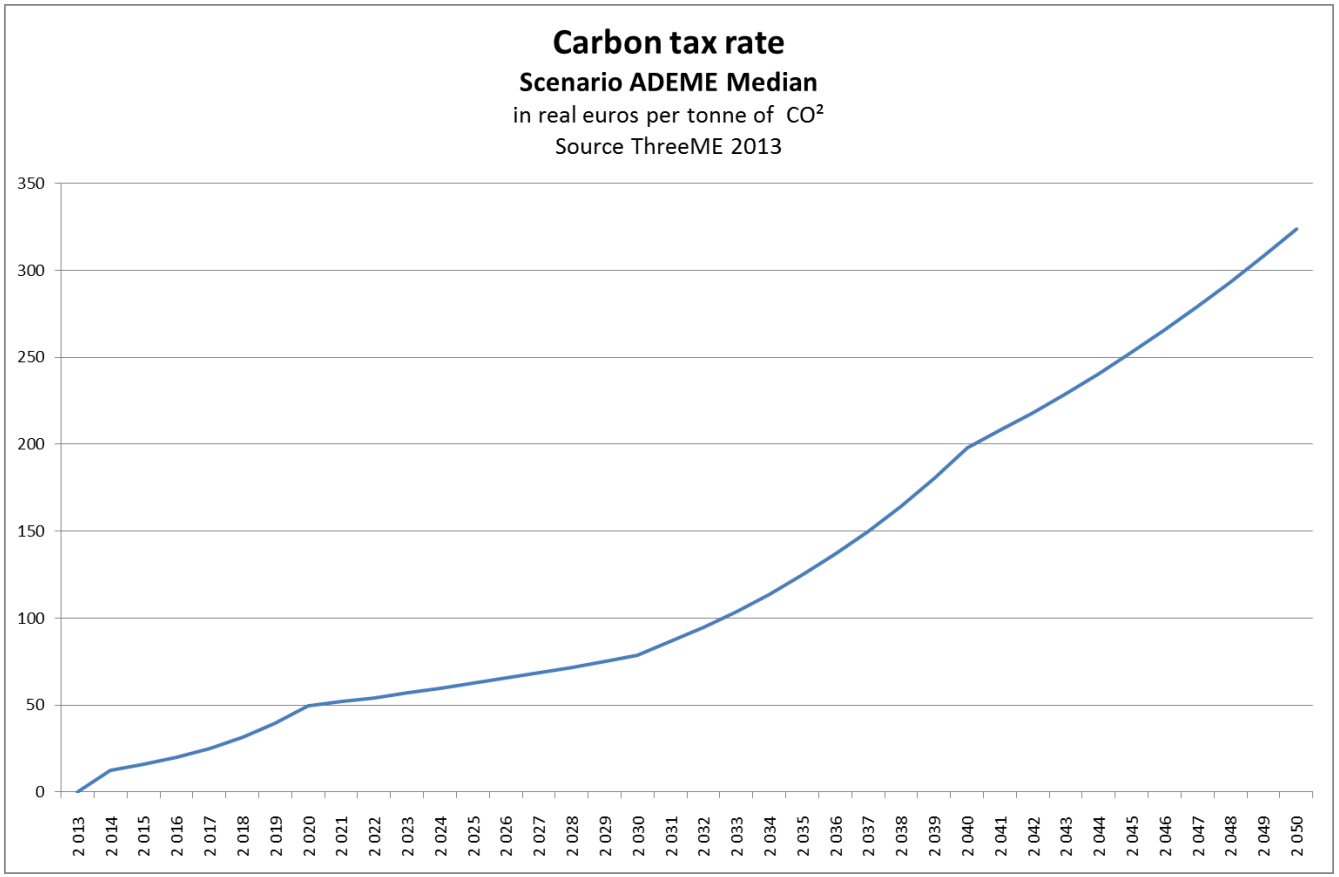


The trade-off deficit is lower in the scenario Haut since the propensity to import equipments is weaker in the nuclear sector than others.

The public Debt evolution in % GDP



The carbon taxe rate in €/tCO2



- without redistribution, the carbon tax has a negativ effect on GDP
  - Simulation of the Quinet scenario : -0,3% in GDP in long term
  - Impact on employment near zero, thanks to a growth in investment (energy efficiency)
- With a redistribution, the tax has a positiv effect on GDP and employment in the long term :
  - Decrease in labor cost
  - Growth of the sectors which do not consume a lot of energy
  - Increase in labor intensity and reduction in imports
  - In the long term, the net present value of investments is positive (the reduction in the energy bill is higher than the debt reimbursment)
  - The expansive effect of the tax redistribution is more important than the recessive effect of the tax increase.

A double dividend

- Increase in jobs and economic activity, decrease in GHG
  - *GDP growth difference by **3% in 2050** with respect to the BAU scenario.*
  - *In level, GDP X2 between 2012 and 2050*
  - *Decrease in unemployment rate by **1.6 pts in 2050**. and the creation of more than **800 000 jobs***
  - *GES emissions divided **by 4 since 1990**, reduction by 50% in energy demand*
  - *Carbon tax rate near **350€/tCO2 in 2050***